DUAL FILTER WITH FLOW MIXER AND CENTRIFUGAL SEPARATOR

Related Patent Applications

This application is a continuation-in-part of both U.S. Patent Application Serial No. 09/474,061, filed on December 29, 1999 and U.S. Patent Application Serial No. 09/398,459, filed on September 17, 1999.

Field of the Invention

The present invention relates to dual filters having a full flow filter element and a bypass filter element. More particularly, the present invention relates to a dual filter having a full flow filter element and a bypass filter element arranged in tandem with auxiliary structure which enhance filtering function.

Background of the Invention

Filter cartridges used for filtering fluids such as lubricating oil can be arranged with a full flow filter element and a bypass filter element, the bypass filter element being stacked on the full flow filter element with the fluid flowing radially through the filter elements into hollow cores thereof and then axially out of the canister.

This arrangement is widely employed to filter lubricating oil used in internal combustion engines. Engine wear, specifically piston ring wear, is directly related to the amount of actual filtration of lubricating oil by both full flow and bypass filters which is mixed after filtration. It has been found that by combining filtration provided by a full flow filter element with that of a bypass filter element substantially reduces engine wear as compared to using only full flow filtration. Moreover, by using a combination of full flow and bypass flow lubricating oil, service intervals can be increased so that maintenance expense is reduced. Maintenance expense is a major consideration in the total expense of operating a vehicle. This is, of course, a major concern for fleets of vehicles,

such as the fleets operated by trucking companies. In addition, by keeping lubricating oil clean, it can remain in engines longer and does not have to be recycled at shorter intervals. Consequently, environmental concerns due to vast amounts of used lubricating oil are reduced because less used oil must be recycled. It is therefore beneficial to enhance the performance of lubricating oil cartridges which utilize both full flow filter elements and bypass filter elements.

Summary of the Invention

In view of the aforementioned considerations, it is a feature of the present invention to provide a filter for removing particles from a fluid wherein the filter comprises a canister having a first end with radially disposed inlet openings and a central outlet opening and having a second end which is closed. A first filter element having a small particle annular filter media defining a first substantially cylindrical hollow core is disposed adjacent the first end of the canister. A second filter element having a sludge removing annular filter media defining a second substantially cylindrical hollow core is stacked axially with respect to the first filter element. A flow mixing element connects the second hollow core to the first hollow core and includes a flow deflector which imparts a rotational component to the fluid as the fluid flows axially from the first hollow core to the second hollow core. Consequently, fluid flowing radially through the small particle filter media mixes with the rotating fluid which has been filtered by the second filter media before passing through the central outlet opening of the filter canister. The capacity of the filter is increased by providing an array of angled fins which impart rotation to the fluid around the filter elements after the fluid enters the canister and flows toward the second end of the canister.

In another aspect of the invention, the flow mixing element comprises an annular channel formed about a core, the annular channel having a flow deflector therein, which in a more specific aspect of the invention comprises at least one axially-extending angularly displaced rib.

In a further aspect of the invention, the afore-described rib extends across the annular channel and supports the core of the mixing element therein. In a more specific aspect, the core has at least one end which is closed to the passage of fluid so that the fluid flows from the second hollow core to the first hollow core only through the annular channel.

In still further aspects of the invention, the filter is arranged with the first filter element disposed above the second filter element and with a chamber within the canister below the second filter element for accumulating particles separated from the fluid by centrifugal force to keep those particles out of the filter elements.

In a specific embodiment, the aforedescribed filter is used to filter lubricating oil for internal combustion engines.

Brief Description of the Drawings

Various other features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts through the several views, and wherein:

Figure 1 is a side elevation, of a filter configured in accordance with the principles of the present invention;

Figure 2 is a perspective view of a flow-altering element utilized with the cartridge of Figure 1;

Figure 3 is a bottom view of the flow control element of Figure 2;

Figure 4 is a side view of a filter element having attached thereto a fin array ring, and

Figure 5 is an end view of the filter element of Figure 4 with the fin array ring attached.

Detailed Description

Referring now to Figure 1, there is shown a filter cartridge 10, configured in accordance with the principles of the present invention, wherein the filter cartridge 10 includes a canister housing 12 having a first end 14 and a second end 16 which is formed. The first end 14 includes an end plate 18 which has a plurality of radially-spaced inlet openings 20 and a central axial opening 22 which is coaxial with an axis 24 of the filter canister. The end plate 18 is retained at the first end 14 and within the canister 12 by a crimped retaining arrangement 26. Preferably, the filter cartridge 10 is mounted with the axis extending at least generally vertically and the first 14 being the top end and second end 16 being the bottom end.

The canister 12 is configured in accordance with a preferred embodiment of the invention as a filter canister for filtering lubricating oil used in internal combustion engines wherein the central outlet 22 has internal threads 30 which are threaded onto a hollow stud (not shown) projecting from an engine (not shown) to allow filtered oil to return to the engine. The plurality of radially spaced inlet openings 20 are isolated from the stud and allow lubricating oil to flow into an annular space 32 which is defined by a filter element support 34 that rests on the inner surface of the end plate 18 and surrounds a collar 36 which has the thread 30 on the inner surface thereof.

Urged against the filter element support 34 is a first filter element 40 which is a full flow filter element. The first filter element 40 has a diameter less than the diameter of the housing 12 so that an annular inlet channel 42 is created between the filter element 40 and the inner surface of the wall of the canister 12. The first filter element 40 is comprised of an annular small particle filter media 44 having a first hollow core 46 therein and having first and second ends closed by first and second end caps 48 and 50. The first end cap 48 is urged against the annular support 34, while the second end cap 50 is annular defining a hole 52 therethrough, which hole receives a first flow-deflecting element 56 disposed internally with respect to the filter elements 40 and 70. The

first flow deflecting element 56 has a first end 58 that projects into the first hollow core 46 and a second end 60 which projects and below the first filter element 40 to impact a non-axial component to fluid flowing out of the filter media 44. The flow 56 has a radially projecting flange 62 which rests on the flange 50 so as to be sandwiched between the first filter element 40 and a second filter element 70.

A second filter element 70 which is stacked herewith the first filter element 40 and has a portion of the annular inlet channel 42 therearound has an annular sludge removing filter media 72 which defines therein a second hollow core 74, which second hollow core 74 communicates with the first hollow core 46 through the flow-altering element 56. The second filter element 70 has a first end closed by a first annular end cap 76 which has an opening 78 therethrough which receives the second end 60 of the flow-altering element 56 and abuts the top surface of the radial flange 62 so as to clamp the flow-altering element in place with the second end 60 of the flow-altering element received within the hollow core 74 of the first annular filter media 72. At the second end of the sludge removing filter media 72 is a second end cap 80 which is configured as a closed disk without a center opening. The second end cap 80 is engaged by a coil spring 82 which abuts the closed second end 16 of the canister 12 to urge the second filter element 70 against the radial flange 62 of the flow-deflecting element 56 that in turn abuts the first filter element 40 and holds the first filter element against the filter element support 34.

Dirty lubricating oil 85 flowing in the annular inlet channel 42 which does not flow radially through the first filter media 44 flows radially through the second filter media 72 and then through the first flow-deflecting element 56.

Referring now to Figures 2 and 3 in combination with Figure 1, the first flow-deflecting element 56 is configured as a cylindrical insert with an annular channel 90 disposed between an outer cylindrical sleeve 92 and an inner cylindrical sleeve 94. The outer sleeve 92 and the inner sleeve 94 are held in space with respect to one another by at least one rib 95. Preferably, there are three ribs 95 which extend between the inner circular sleeve 94 and outer

circular sleeve 92 so that the annular channel 90 is divided into three circumferentially-spaced channels 96. As is seen in Figure 1, the three ribs 95 extend axially in the direction of the axis 24 but are angularly spaced with respect to the axis as the ribs 95 progress from the second end 60 of the flow-deflecting element to the first end 58 thereof. Each of the channels 96 are deflected in the same direction. Consequently, as the fluid flows through the channels 96, it is given an angular component and therefore emerges from the end 58 of the flow-deflecting element so as to impart a spiraling motion to the fluid indicated by the arrow 98.

The spiraling fluid 98 mixes with fluid 99 which has passed radially through the first filter media 44 and then changes direction and flows axially out of the outlet 22. The resulting fluid stream 100 flowing out of the outlet 22 is therefore a mixture of this fluid 98 and the fluid 99.

The aforedescribed arrangement is especially useful with lubricating oil filters wherein the first filter element 40 is a full flow filter element and the second filter element 72 is a bypass filter element. It has been found desirable to mix the lubricating oil which has been filtered by the bypass filter element 72 with the filter oil filtered by the full flow filter element 40 before returning the oil to the engine in the flow stream 100 passing through the outlet 22. This arrangement is especially useful when the second filter element 72 which forms the bypass element is arranged for recycling sludge generated by the internal combustion engine while the full flow filter element 40 traps only particles or dirt. Consequently, as the oil stream undergoes many passes through the filter cartridge 10, the first filter element 40 traps primarily dirt or particulate matter in the filter media 44, while the second filter element 70 traps primarily sludge in the second filter media 72. Thus, the first filter media 44 has an increased dirt-holding capacity because it does not also trap sludge, thereby rendering the entire filtering system provided within the cartridge 10 with an increased capacity and efficiency that improves lubricating oil filtration and substantially increases the interval between oil filter changes.

The inner sleeve 94 provides a hollow core 98 which has adjacent the end 90 an end wall 99 so that the fluid flowing radially through the second filter media 72 of the second filter element 70 is forced to pass through the channels 97 of the annular channel 60. Most of the fluid tends to flow into the hollow core 98 which forms a cup that helps retain contaminants which have passed through the filter media 72 of the second filter element 70.

In order to further increase capacity and efficiency of the filter cartridge 10, an external array 120 of fins 122 provides a second deflector which is positioned in the annular inlet channel 42 just down stream of the inlet openings 20 adjacent to the first end cap 48. The array 120 of fins 122 imparts a rotational motion to the fluid 99 prior to the fluid entering the first filter element 40 so that the fluid spirals in the direction of arrows 123 around the first filter element causing relatively large particles to migrate centrifugally toward the inner surface 124 of the cylindrical wall 126 comprising the housing 12 instead of passing through the small particle filter media 44 of the first filter element 40. Accordingly, it is mostly smaller particles of dirt or contaminant that pass through the first filter element 40.

The fluid continues to spiral as it moves in the annular inlet space 42 toward the second filter element 70, keeping a substantial quantity of large particles away from the second filter element so that the second filter element mainly traps sludge in the sludge removing filter media 72, a substantial portion of the large particles remaining suspended in the oil near the surface 124 of the canister wall 126 and never passing into the second filter element 70.

The large particles which have avoided filter elements 40 and 70 pass through a gap 130 between the end cap 80 of the second filter element 70 and the surface 124 of wall 126. The particles then become trapped in a chamber 134 defined by the domed second end 16 of the housing 12. The gap 130 is maintained by the spring 82 which urges the second filter element 70 against flange 62 of the flow deflecting element 56 which in turn abuts the first filter element 40 to urge the first filter element against the filter element support 34.

Since the chamber 134 is beneath the second filter element 70, the heavy particles settle out and accumulate against the inner surface of the domed end 16.

As is seen in Figures 4 and 5, the array 120 fins 122 is preferably unitary with an annular band 140, the fins being disposed at an angle of approximately 45° with respect to the axis 24 of the filter canister 10. The annular band 140 has a plurality of inwardly projecting tabs 142 which extend radially over and engage the first end cap 48 in order to retain the array 122 of fins 120 adjacent to the first end cap 48 at the top of the first filter element 40.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.